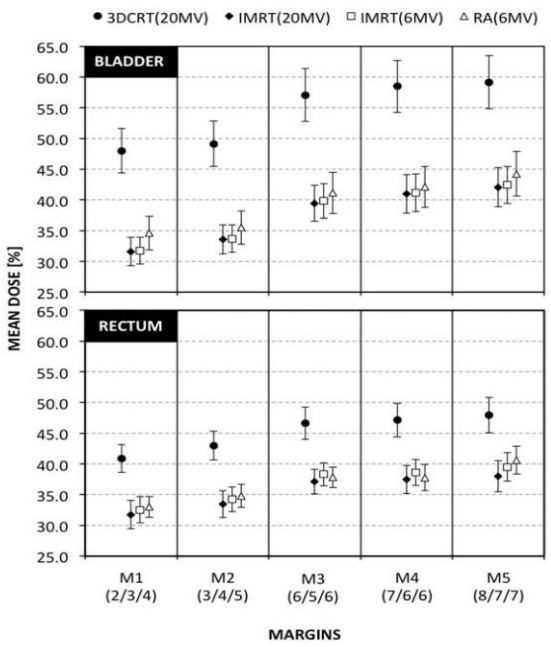

Conclusions: The choice of the appropriate method of irradiation (3DCRT vs dynamic techniques) and using the appropriate margin determining the image verification method (daily verification vs verification for the first fractions) significantly affects the average doses in the bladder and rectum.

PO-1102

Toxicity analysis in Helicoidal-IMRT (HT) treatment for head and neck tumors

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Purpose/Objective: Radiation-induced dysphagia is an undesirable toxicity in head and neck cancer (HNC) treatment. Radiotherapy (RT) delivered with HT might mitigate this toxicity. This is a retrospective review of HT treatment plans relating planning target volumes (PTVs) and organs-at-risk (OAR) dosimetry to severe toxicities.
Materials and Methods: Seventy two HNC patients treated with curative HT were included, 55% of whom had stage IV disease and 47% localised in the oral cavity and oropharynx. Dose for definitive RT was 70 Gy and for post-operative RT 60-66 Gy. 47% of patients received a simultaneously integrated boost. Severe G3-4 early and chronic toxicities (CTCAE version 3.0 and RTOG/EORTC scoring system) were scored and correlated with common risk factors. Dose distributions to PTVs and OARs were correlated to severe toxicities and treatment effectiveness, using COX regression and contingency analysis. Overall treatment time of radiation therapy (TTT) was reported, with 10 patients having been replanned during RT due to anatomical changes.
Results: Age resulted in more acute severe toxicity. Older patients (>64y) had more pain and xerostomia (p=<0.0001) and younger patients had more dysphagia and dermitis (p=<0.0001) in a multivariate analysis. Median pathologic PTV volume was 131 cc (109-153 cc) and elective PTV 345cc (288-402cc). We achieved excellent pathologic PTV coverage with the isodoses 95%, 98% and 2% covering 98%, 97% and 103% of volume, respectively. Isodoses 95%, 98% and 2% of elective PTV covered 100%, 98% and 127% of volume. Severe early toxicities were 31% mucositis, 11% pain, 7% xerostomia, 52% dysphagia and 45% dermitis; 21% of patients developed severe chronic dysphagia. Larger p. PTVs (>131 cc) resulted in significant higher early dysphagia rates (64.8% vs. 35.14% (p=0.02)) and late dysphagia rates (47.9% vs. 52% (p=0.059)). Wider PTVs showed a trend of correlation to decreased overall survival rates (OS at 3y, 36% vs.74% (p=0.23)). Concerning TTT, only 24% of patients had a standard treatment duration (<47 days), 40% had an intermediate TTT prolongation deviation (47 to 54 days) and 8% an important TTT prolongation (>54 days) in TTT, with 29% of patients start treatment on Thursday or Friday. TTT was not related with acute or late severe toxicities, neither with OS. Patients replanned during treatment (10 p) experienced more acute toxicity (pain and xerostomia p<0.01), but not an improved in locorregional control or OS. Replanning induced significant longer TTT (p=0.0001).
Conclusions: The use of HT improves the coverage of PTV volumes preserving salivary glands, even in great volumes. Higher doses to ipsilateral parotid (28Gy) and submaxilar gland (58Gy) seem to be related to severe toxicity. Replanification is related to more toxicity without improvement in disease control. Different toxicities by ages can be related with other factors like HPV presence (younger patients) and basal atrophic salivary glands (older patients).

PO-1103

Geometric and actual dose delivery accuracy in supine and prone position of breast tomotherapy

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Purpose/Objective: This study aims to evaluate the geometric and actual dose delivery accuracy in supine and prone positions of breast tomotherapy.
Materials and Methods: Forty early breast cancer patients were recruited for tomotherapy after breast conservation surgery. The breast cup size was ≥ C and TNM staging was T0-T3, N0-N1, M0. All patients received 25 fractions of treatment with 2 Gy/fr to total 50 Gy. Thirty were treated in supine position on customized vaclok during planning and treatment and ten were treated in prone position immobilized on prone breast board with customized vaclok. Daily MVCT was performed for treatment verification. For lateral, longitudinal and vertical dimensions, the offset distances in terms of mm before couch adjustment were recorded; while for the roll dimension, the degree of angle rotated were recorded. The difference in coordinates before and after matching in these four dimensional directions were recorded in each fraction for each patient. Systematic (SE) and random (RE) errors were calculated from the

translational differences for comparison. Daily merged CT image was created for each patient by substituting the MVCT to corresponding portion of planning CT based on the offsets obtained during treatment verification. TomoTherapy Planned Adaptive software was used to recalculate the daily dose distribution on the merged CT. MIM software was used to accumulate all recalculated daily doses by deformable fusion to give the total actual dose. The mean percentage difference (MPD) between the actual and planned doses of targets and OARs were then calculated for analysis.

Table 1: Mean percentage difference (MPD) between actual and planned doses in supine and prone positions.

		MPD – Supine (%) Mean ±SD	MPD – Prone (%) Mean ±SD	p value
CTV	$D_{2\%}$	-0.78±1.05	0.12±1.26	**0.0413**
	$D_{95\%}$	-1.59±1.27	-1.96±4.04	0.2245
	$D_{98\%}$	-2.45±1.77	-3.46±5.70	0.4449
PTV	$D_{2\%}$	-0.83±1.14	0.40±1.29	**0.0079**
	$D_{95\%}$	-2.77±1.72	-2.92±1.91	0.4710
	$D_{98\%}$	-4.13±2.32	-5.91±4.04	**0.0215**
Ipsilateral lung	V_{20Gy}	2.79±8.40	2.92±19.16	0.2954
Contralateral lung	V_{20Gy}	1.85±80.37	-16.19±29.49	0.5565
Contralateral breast	D_{mean}	-2.50±2.33	-2.36±8.25	0.9319
Heart	D_{mean}	0.14±3.95	1.44±3.64	0.3643
	V_{15Gy}	-2.30±13.93	1.33±18.55	0.5153
Spinal cord	D_{max}	4.84±15.13	13.15±28.82	0.7548
Liver	D_{mean}	-1.58±7.97	-1.10±14.24	0.8936
	V_{8Gy}	-3.58±25.05	-4.02±16.01	0.8882

Results: The setup deviation in supine position was significantly smaller than in prone position, in which the lateral, longitudinal, vertical and roll direction were 0.27 vs 1.53 mm, 0.37 vs 1.23 mm, 0.37 vs 1.34 mm and 0.11 vs 0.43 ° for RE (all $p < 0.05$), and 2.08 vs 6.32 mm, 2.30 vs 4.62 mm, 3.14 vs 4.61 mm and 0.31 vs 1.13 ° for SE respectively (all $p < 0.05$ except vertical direction). All dose results are shown in Table 1. For prone position, the MPDs of both CTV and PTV were significantly smaller in $D_{2\%}$ ($p = 0.0413$), but they were greater in $D_{95\%}$ and $D_{98\%}$ in which PTV $D_{98\%}$ showed significant difference ($p = 0.0215$). The opposite signs in MPD of $D_{2\%}$ and $D_{95\%}$/ $D_{98\%}$ in prone position implied the loss of target homogeneity. For OAR doses, the MPD were smaller in supine than in prone position except D_{mean} of contralateral breast and liver and V_{15Gy} of heart. The actual heart dose was in fact increased in prone position (+ve MPD) while decreased in supine position. No significant results were found in MPD of all OARs.

Conclusions: Supine position was found to have better geometric accuracy. The MPDs for most of the targets and OARs in supine position are smaller than that in prone position, implying higher accuracy in delivering the planned dose. All these suggested supine setup gain more patient stability during actual treatment.

PO-1104

Effects of range uncertainties and setup errors in craniospinal proton treatment plans

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Purpose/Objective: Comparisons of proton and photon dose distributions in treatment plans have clearly demonstrated that protons offers superior normal tissue sparing, decreased integral dose and excellent dose coverage in craniospinal (CS) irradiation (Howell et al, RO, 2012). However, protons are especially sensitive to range uncertainties and setup errors and have, if not properly accounted for in the planning process, the potential of causing large disturbances in the planned dose distribution. The aim of this study has been to analyse the effect of range uncertainties and setup errors in CS proton treatment plans.

Materials and Methods: Intensity Modulated Proton Treatment plans (IMPT) was created for 6 paediatric patients in the Eclipse treatment planning system (Varian Medical Systems, Palo Alto, CA, USA). The CTV included the whole brain and the spinal canal to the junction area between the second and third sacral vertebrae. The CTV-PTV margin applied was 4 mm, in addition the PTV was expanded to also include the entire corpus vertebrae, this to avoid a possibly future asymmetric growth of the skeleton (Eifel et al, IJROBP, 1995). The beam arrangements consisted of 2 lateral oblique fields to cover the brain and the upper cervical spine, and 2 posterior fields to enable coverage of the whole spinal canal. The prescribed dose was 36 Gy (RBE) in 20 fractions and evaluated by standard criteria. Setup errors were introduced by shifting the isocenter in the treatment plans by ±1-5 mm in lateral, longitudinal and vertical directions. Range errors was modelled by changing the Relative Stopping Power in the CT calibration curve for ±1-5 %, thus generating a decrease (undershoot) or increase (overshoot) in the estimated proton range. The treatment plans where then recalculated with the initial spot distribution and evaluated in terms of CTV dose coverage and the doses to the heart, thyroid and lungs.

Results: The largest reduction in the CTV dose was caused by a 5 mm caudal isocenter shift and an undershoot of 5 %, resulting in a reduction in the $V_{95\ \%}$ from 100 % to 97.7 % and 97.3%, respectively. This corresponds to a percentage change of - 2.3 % and - 2.7 %, respectively (Table I). The heart dose was most sensitive to the range uncertainties and setup errors in the left direction, increasing the $V_{5Gy(RBE)}$ from 4.2% to 6,7 % with 5 mm left isocenter shifts or a 5 % overshoot. Range uncertainty had the largest impact on the thyroid dose, the $V_{5Gy(RBE)}$ from 50.9% to 72.3 % following a 5% overshoot. Only the LR setup error affected the lung dose, demonstrated by the increase in $V_{5Gy(RBE)}$ in the right lung due to the isocenter shifts in the right direction (Figure 1).